En
GODFR

AGRICULTURAL RESOURCES

OF THE

PUNJAB;

BEING A

MEMORANDUM ON THE APPLICATION

OF THE

WASTE WATERS OF THE PUNJAB

TO

PURPOSES OF IRRIGATION.

BY

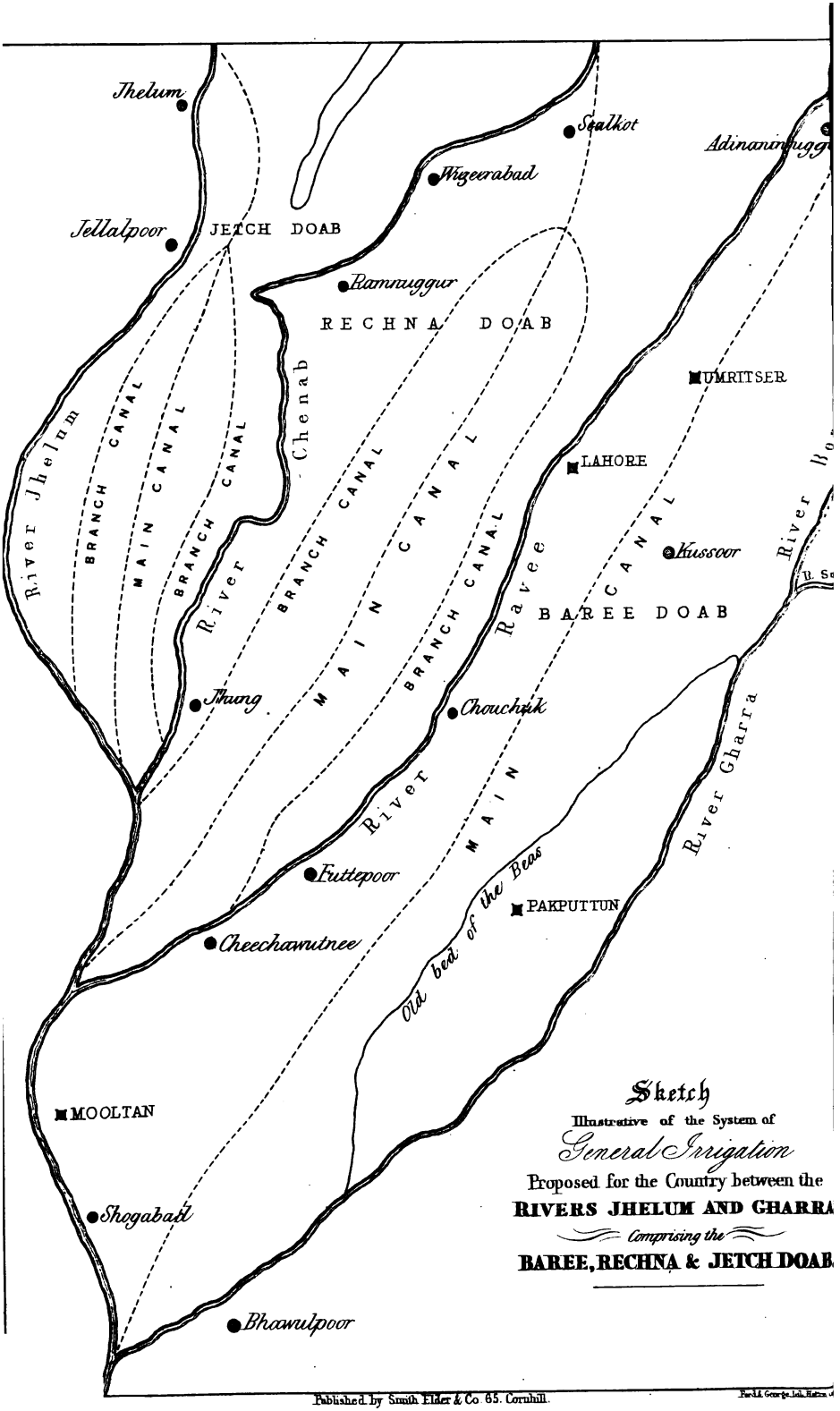
LIEUTENANT R. BAIRD SMITH, F.G.S.,

BENGAL ENGINEERS:

SUPERINTENDENT OF THE EASTERN JUMNA CANAL, AND
ASSISTANT FIELD ENGINEER WITH THE ARMY OF THE PUNJAB.

LONDON:
SMITH, ELDER AND CO., 65, CORNHILL.

1849.



Published by Smith Elder & Co. 65. Cornhill.

AGRICULTURAL RESOURCES

OF THE

PUNJAB;

BEING A

MEMORANDUM ON THE APPLICATION

OF THE

WASTE WATERS OF THE PUNJAB

TO

PURPOSES OF IRRIGATION.

BY

LIEUTENANT R. BAIRD SMITH, F.G.S.,

BENGAL ENGINEERS:

SUPERINTENDENT OF THE EASTERN JUMNA CANAL, AND
ASSISTANT FIELD ENGINEER WITH THE ARMY OF THE PUNJAB.

LONDON:

SMITH, ELDER AND CO., 65, CORNHILL.

1849.

London:
Printed by STEWART and MURRAY,
Old Bailey.

TO

PROBY THOMAS CAUTLEY,

This little Work,

SANCTIONED BY HIS APPROVAL,

IS INSCRIBED

BY HIS ATTACHED FRIEND,

THE AUTHOR.

AGRICULTURAL RESOURCES

OF THE

PUNJAB.

INTRODUCTORY REMARKS.

THE accompanying paper was prepared during the progress of the Sikh campaign of 1848-49, now happily terminated by the incorporation of the Punjab with the British Empire in India. It was commenced shortly after the battle of Ludoolapoor, when a temporary cessation of active operations admitted of attention being given to other than purely military occupations; and, after inevitable interruptions caused by the movements of the army previous, and also subsequent, to the battle of Chilianwala, it was finished shortly after that memorable event. As the author was actively engaged in all the operations of the campaign, some indulgence may be sought for imperfections of style. For the data given, or the conclusions based upon them, no indulgence is necessary. The former are either derived from official sources, in which every confidence may be placed; or, when obtained otherwise, their value is fairly indicated. The latter follow legitimately from the facts specified; and it is believed that,

within reasonable limits of error, they are worthy of confidence. The view of the agricultural resources of the Punjab submitted, is a general view only, and no attempt has been made to refine on data for which rigid accuracy is not claimed. There was no time, no opportunity, for those minute surveys and preliminary investigations which would naturally precede the actual execution of such works as are suggested. But, if the general value of the important acquisition now made be established, and its improvement forwarded, the author's object will be fully accomplished.

It must necessarily be an object of interest, both to the Indian and Home governments, to open the Punjab freely to British commerce. The works suggested in this paper, although primarily agricultural, may yet be made to promote commercial interests, in a very important measure. Independently of the effect they would have in exciting and increasing the demand for English goods, by augmenting largely the wealth of the agricultural classes,—by far the largest body of consumers in the kingdom,—the canals would facilitate transit just at those points where the rivers of the Punjab cease to be available, or, if available, are so only with great difficulty and delay. The cost of adapting a canal of irrigation for transit is about one-twentieth of the entire outlay required; and by an addition of not more than 5,00,000 rupees, or 50,000*l.*, to the sum required for irrigation alone, nearly 800 miles of inland navigation would be formed, stretching like a net-work over the surface of the country, and linking all its great towns and marts with each other, and with the rivers, which, uniting in the

Indus, connect the Punjab with the sea. A reference to the accompanying outline map will show where the suggested canals will terminate. To these termini the rivers are navigable without any serious difficulty. North of them, however, difficulties increase rapidly, and there is very little hope to be entertained that they can ever be efficiently overcome. Artificial lines, therefore, may be made to replace these inefficient natural ones; and, with the improvement of the agriculture of the country, its internal and external commerce may, by the same means, be vivified and extended.

So little is known in England of the extent and value of the irrigation system of Northern India, from which the data employed in this paper are derived, that it may, perhaps, be interesting to give here a condensed and rapid sketch of its general features.

Indian canals of irrigation are essentially artificial rivers, having the inclination of their beds regulated by the introduction of masonry falls; to which, for purposes of navigation, chambers, gates, sluices, in a word, all the machinery of locks on ordinary reservoir canals, are adapted, with only such modifications as the existence of a considerable current requires. All the irrigation canals now in existence in this country are derived from Himalayan rivers, and the drainage of this great chain, where it crosses their beds, is controlled and regulated by dams of large dimensions, maintained amid great engineering difficulties, and liable, during the periodic rainy season, to serious damage from floods. When rivers at lower levels interfere with the course of the canals,

aqueducts carry the water over them. The cross communications of the country are maintained by numerous bridges and immense numbers of masonry works of all kinds: inlets, outlets, irrigation drains, and sluices, &c., are scattered over the country through which the lines pass.

The water is sold to the cultivators, and distributed to the lands, either directly from the main canals, by openings of fixed dimensions in their banks, or indirectly by means of subordinate channels of smaller dimensions, designed to supply a limited number of villages. The latter is the favourite method; and with reason, as it has many advantages, especially in facility of control and distribution, over the former.

Two systems of assessment are employed:—1st. The measurement system; under which water-rent is levied on ground actually measured after each crop, and rates charged, which are discriminating, both as regards the nature of the grain grown and the manner in which irrigation is supplied: *i. e.*, whether by natural flow over the land or by means of irrigating machines. 2nd. The contract system; under which rents are levied on the area of outlet, variable in amount according to the facilities for irrigation in each particular case, but fixed for periods of twenty years. Under both systems, the average rate at which water is supplied amounts to about one rupee, or two shillings, per acre. There is, however, no branch of the canal system which so imperatively requires reforming as the assessment; and, should canals of irrigation be introduced into the Punjab, it is to be hoped that the principles on which the water-rent is levied, may be established

on a sounder and more scientific basis than now prevails. It is scarcely possible to conceive a ruder or more cumbrous plan than the first mentioned; which entails the measurement, twice a year, of every field irrigated, and which checks the extension of the valuable crops by the higher rates imposed upon them. The contract system is a step in advance; but it is very imperfect, and open to many grave objections as it now exists. This question is, however, too large to be discussed here, and this slight reference to it must suffice.

To give special illustrations of the preceding general outlines, the canals of the Jumna, the most important irrigating lines at present in existence, may be adverted to.

The river Jumna supplies two canals, denominated, respectively, the Eastern and Western Jumna Canals. Both were excavated, originally, during the period of the Mahomedan supremacy; the former in Shah Jehan's reign, about the year 1626, the latter about three hundred years earlier, in the time of Feroze Shah, A. D. 1350. During the administration of the Marquis Hastings in 1817-18, the restoration of these old canals first attracted attention, and in 1821 the Western Jumna Canal was re-opened: nine years afterwards the Eastern Jumna Canal was brought into active operation. This canal, leaving the Jumna under the Siwalic or sub-Himalayan range, rejoins it near Delhi, after flowing about 145 miles. Its subordinate channels, each a small canal with its complement of masonry works, exceed at this time 490 miles in length, and are extending annually. Not less than 2,000 miles of village water-courses

spread their waters over the adjoining fields. It supplies 600 separate villages, covering 497 square miles of area, and containing a population of about 300,000 souls. From the lands under its influence, Government derives a revenue of upwards of 60,000*l.* per annum, which never fluctuates, as the crops are secured against all ordinary vicissitudes of the seasons. The agricultural produce thus secured is valued at nearly half a million sterling per annum, about an eighth of which forms the Government land rent, the remainder being the property of the village communities.

The discharge of this canal is about 600 cubic feet per second. Its cost in works, up to the present time, has amounted to nearly 90,000*l.*; and its maintenance in repairs and establishments, European and native, entails an expense of nearly 7,000*l.* per annum. Its direct income amounts to nearly 15,000*l.* annually; and its indirect returns, from increase of land revenue derived from canal villages, are equal to about as much more; so that by an investment of 90,000*l.* Government has secured a permanent revenue of not less than 25,000*l.* per annum. This large revenue is obtained, under the happiest circumstances, by contributing directly to the prosperity of the people; who, in districts to which canal irrigation has been thus plentifully extended, are in a state of material comfort far exceeding the average of other parts of the country.

The Western Jumna Canal is nearly four times as large as that on the eastern bank of the river. It has a discharge of 2,270 cubic feet per second, and, with its branches of large dimensions, has a course of

about 430 miles in length. Its annual income is about 30,000*l.*, its current expenditure about 12,000*l.*, and its cost for works has, up to the present time, amounted to about 140,000*l.* It has enabled Government to derive from the tract of country under its influence a land revenue of 29,000*l.* per annum, in excess of what otherwise would have been obtained; and the use of its water has redeemed a large portion of the districts of Hansi and Hissar from utter and hopeless sterility.

During the troubled periods of the latter Mahomedan Emperors, the old canal had become useless, and the country was consequently depopulated and reduced to the condition of a desert. Wherever the canal now extends, the richest cultivation covers the lands; the villages are prosperous and the population abundant. The total area of irrigated land amounts to 1,015 square miles; the population to about 300,000. The land revenue derived from the canal districts is nearly 100,000*l.* per annum, and is placed beyond all risk of fluctuation. The value of produce obtained from lands irrigated by the canal is estimated at 1½ millions sterling per annum, of which about one-tenth reverts to Government as land and water rent, while the remainder supports in great material comfort about 600 village communities. During the great famine of 1837, when the crops failed everywhere else from want of water, the canal districts were safe and flourishing; and no more significant illustration of the beneficial effects of canals of irrigation could be found, than in the contrasts exhibited between irrigated and unirrigated districts, during the progress of this terrible calamity.

Great and desirable improvements are contemplated in the works of the Western Jumna Canal, which are estimated to require an expenditure of from 150,000*l.* to 200,000*l.*, and there is every probability that these important alterations will receive the sanction of Government.

Numerous minor canals have been constructed in the districts of the North-Western Provinces; for details of which space is not available. They are all, however, eminently successful, and contribute much to the improvements of the districts through which they pass.

The greatest work in this department, the Grand Ganges Canal, projected and superintended by Major Proby Cautley, of the Bengal Artillery, is now in progress of execution, and will be completed in about five years. It will have a discharge of 6,750 cubic feet per second, and is expected to cost about 1,250,000*l.* Its total length, navigable throughout, is 898 miles, and it will furnish irrigation to a tract of country, between the rivers Ganges and Jumna, having an area of 5,400,000 acres. Its annual income from sale of water, &c., is estimated at about 160,000*l.*, and the increase of land revenue, which will be derived from the country under its influence, will not be less than 240,000*l.* per annum.

The agricultural produce, which will be secured from loss in those very districts which were the seat of the great famine of 1837, is valued at upwards of 7½ millions sterling per annum; and a population of nearly 6½ millions of souls will be saved from a recurrence of those appalling scenes of misery which are still fresh in public memory. Under the influence of

irrigation, the produce of the soil will be increased to an amount valued at 1,200,000*l.* per annum; and this result will be obtained at a cost to the cultivators less by 2½ millions sterling annually than if the only other method of irrigation practised (that by wells) had been employed.

The works of the Ganges Canal are of magnitude unprecedented in India. The great aqueduct across the Solani river alone, will require for its construction nearly 90 millions of the large bricks employed in this country, and a million cubic feet of lime, employing nearly 6,000 men daily, for five years, on the masonry and earth work connected with it. The other works are of proportionate magnitude; and the whole, when finished, will form a monument worthy of our national character, and will leave lasting proof that the British Government in India is not so unmindful of the great interests committed to its charge, as some would desire to have it believed. The works are advancing with great energy; and, to his honour be it stated, that, even during the enormous financial pressure of the late campaign, the Governor-General of India, Lord Dalhousie, would admit of no check being given to an undertaking calculated to promote so materially the best interests at once of the Government and the people.

Existing canals of irrigation constructed in the infancy of our knowledge, and in the most economical manner possible, have, in some localities, unquestionably caused sickness. But this result has been so manifestly due to the imperfections of the canals, their interference with the natural drainage of the country, and the consequences thereof, in the formation of

occasional swamps, that there is no cause for anxiety regarding the effects of the extension of irrigation, by means of canals from which all these imperfections are removed. It admits of the clearest statistical proof that simple irrigation, whether from canals or wells, is not in itself a cause of sickness; and, if due care is taken to preserve the drainage of the country unimpeded,—a simple enough operation,—all the benefits of the system, without the sole evil which has hitherto been found in some spots to accompany it, will be secured.

There are many projects under the consideration of Government for new canals in the North-Western Provinces, to which it is impracticable to advert here. Doubtless, as means are available, they will be carried into effect; as in this department the energy and liberality of Government are unquestionable.

In the noble territory just added to the British Empire, the same vigour may, it is to be hoped, find a new field of action; and if it do, the Future of the Punjab will be as bright and cheering as its Past has been gloomy and disturbed. For ages the battle-field of nations; placed in the direct path of those barbarous Central-Asiatic hordes, to whom the rich plains and wealthy cities of Hindostan were a constantly recurring temptation, and always an easy conquest; torn for generations by fierce intestine feuds, or, when at peace, ruled by an oppressive, cruel, and fanatical race, the classic land of the Five Rivers has none other than mournful associations. Better days are coming. The strong hand of the British Government will secure peace in the land; its servants will bring to its administration the experience, skill, and high

principle which distinguish them; the various races forming its population will pursue peaceful courses, without interfering with each other; its agriculture—the basis of its prosperity—will be cherished, its commerce extended, and its mineral resources developed.

The present revenue of the Punjab is popularly, and probably with tolerable accuracy, estimated at Rs. 1,75,00,000, or 1,750,000*l.* per annum. The details given in the Memorandum shew reasonable grounds for believing that this revenue may, under British influence, be at least doubled. The soil of the Punjab, provided with abundant means of irrigation, is in general well adapted for the culture of the richer classes of Indian produce. Sugar, cotton, indigo, and opium, are now produced in different parts of the country, and such of these as came under the author's personal observation were of superior quality. The means of observation were occasionally curious enough. The writer's first opportunity of noting the quality of Punjab cotton was on the eve of a general action, when he was directed by a gallant officer, more familiar with fighting than Indian farming, to "take a company of Sappers and clear away that low thick *brushwood* in front of the line"—the brushwood in question being a capital crop of the cotton plant!

Under a settled government, and with increased facilities for production, the population of the Punjab, now very scanty in comparison with its area, may be expected to increase rapidly; both from the influence of the natural law which proportions the number of a people to its means of subsistence, and by immigration from adjoining, but less fertile, tracts. The adoption of measures similar to, if not the same as, those

here advocated, will, in the course of twenty years, make the Punjab one of the most profitable and the most prosperous of the many acquisitions which have been won by the Indian army.

Saharunpoor, 1st May 1849.

MEMORANDUM on the Application of the Waters of the Punjab to Agricultural Purposes, with Approximate Estimates of the probable Cost and Returns thereof.

By Lieut. R. BAIRD SMITH, Engineers; Superintendent Eastern Jumna Canal, and Assistant Field Engineer with the Army of the Punjab.

IN the conditions essential to agricultural prosperity, namely, nature and capabilities of soil, profile of surface, supply of water, and habits of the cultivating class, the Punjab has been peculiarly favoured: there are few tracts of country, of equal geographical extent, in the world, for which nature has provided in greater abundance these primary requisites of a highly productive condition. Anticipating the probability that ere long the political circumstances, which, to a great degree, have hitherto neutralized these natural advantages, may be modified, it has occurred to me that it might be of interest, and if not of immediate, perhaps of prospective utility to the Government, to have placed before it certain details calculated to illustrate the, as yet undeveloped, resources of this interesting and important territory.

2. The tract of country to which the following

remarks apply, is a great triangle, the base of which is formed by the hilly country abutting on the southern face of the main Himalayan range, and stretching between the rivers Jhelum and Beas, a distance of nearly 150 miles. The junction of the Gharra (or the united Sutledge and Beas) and the Jhelum forms the apex of the triangle, while those rivers themselves constitute respectively its eastern and western sides. The perpendicular height of this triangle is about 320 miles, and, the base being 150, the total area may be taken approximately as about 24,000 square miles.

3. The country westward of the Jhelum has not been included; because I am personally unacquainted with it, and am therefore unable to speak, with any confidence, of its condition or capabilities.

4. The nature of my professional duties with the army of the Punjab, has afforded me many opportunities of observation on the upper or northern portion of the tract of country, adverted to in paragraph 2. My information regarding the lower or southern portion is derived from the best written authorities I have been able to consult, or from oral communication with officers who have visited it.

5. Describing in general terms, the soil of the Trinab (as the country above alluded to may be termed, to avoid constant periphrasis) may be said to consist of two marked varieties.

1st. A light friable arenaceous soil, productive even with the ordinary supply of rain, but most fertile when provided with the means of abundant irrigation. This prevails largely in the northern part of the Trinab, and produces crops

not surpassed by those of the best irrigated canal districts of our own provinces.

2nd. A heavy stiff argillaceous soil, sterile and most unmanageable without water, but with water capable of producing crops scarcely inferior to those reared on the naturally better soil above noticed. The tracts of waste land lying between the Sutledge and Ravee, and generally the sterile portions of the country between the Gharra and Jhelum, exhibit this hard clayey structure, with exception to occasional patches of sand-hills or pure sand. So long as water is not supplied to this variety of the soil, it must continue to be, as it now is, wholly unproductive, either to the Government or to the community.

6. The total area of a tract of country being given, a deduction from this of one-third of its amount, on account of ground lost to cultivation—as being occupied by sites of towns or villages, beds of rivers, jheels, or unculturable soils—furnishes a fair approximate estimate of the extent of land either actually cultivated, or culturable under favourable circumstances. Consequently, in the Trinab, of which the total area is 24,000 square miles, the cultivated or culturable portion may be estimated at 16,000 square miles, or 13,552,000 acres nearly.

7. For the introduction of an extensive system of artificial irrigation, it is essential that the country to be irrigated should possess a certain profile of surface: *i. e.*, that its slope should be such as to admit of sufficient fall being given to the channels destined for the supply and distribution of the water, to secure in

these velocity of current adequate both to the demand for water and the conservancy of the beds. A slope varying from 9 to 18 or 24 inches per mile has been found by experience to meet the conditions required; and with this slope the velocity obtained is usually such as to insure an efficient supply, with a moderate sectional area of channel; and, further, to preserve the channels themselves from the noxious effects of tropical vegetation—a formidable enemy in such works.

8. All available information regarding the profile of the country between the Gharra and Jhelum, appears to warrant us in concluding that the slope, from the base of the hills to the junction of the two rivers, would be found abundantly sufficient for all purposes of irrigation. From the sections actually taken between the Beas, Sutledge, and Ravee; from the existence of canals east and west of the last noted river, executed in the time of the Mahomedan supremacy; and from the velocity of current in the beds of the rivers, it may be concluded, with considerable confidence, that no difficulties would be experienced, from a deficiency of fall, in covering the Trinab with irrigating channels. As to any difficulties that might be experienced in conveying the water from the supplying rivers to the heads of the canals of irrigation, I confess I have been for many years too familiar with the obstacles overcome in the construction and maintenance of existing canals in the provinces, to be willing to believe that such obstacles would be insurmountable; or that, with the practical skill and pecuniary resources at the command of the Government, the impossible in such matters ought to be otherwise than an almost, if not altogether, exploded idea.

9. The supply of water available for irrigation is the next point, on which some remarks should be made. With reference to this part of the question, information, rigidly exact, does not exist. The details of the dimensions of rivers, given by writers on the Punjab, are so vague and indefinite as to be practically useless. In estimating the quantities of water available for irrigation from each, I have accordingly been guided, in general, by comparison with rivers in our own provinces, the actual discharges of which are known to me; being careful to err rather in defect than in excess.

10. The rivers available for the irrigation of the Trinab, are, first, the Ravee; second, the Chenab; and third, the Jhelum. The discharge of the Ravee, near the point where it issues from the hilly country, and at which the head of a canal of irrigation would naturally be established, has been actually measured by Major Napier, of Engineers, and was found to be about 3,400 cubic feet per second. Of this quantity it may be held that 3,000 cubic feet per second might be applied to agricultural purposes.

11. The discharge of the Chenab has not been numerically determined, but (after having seen both rivers) I am disposed to think that its supply, at its *debouche* from the hilly country, must be very nearly, perhaps somewhat in excess of, that of the Sutledge at the like point. Now the discharge of the latter river at Rooper has been measured by Major Baker, of Engineers, and was found to be about 5,400 cubic feet per second. I therefore assume this discharge to be equal to that of the Chenab at the most northerly point whence a canal could be drawn from it, and that

the supply available for purposes of irrigation from this river may be taken at 5,000 cubic feet per second.

12. For the determination of the discharge of the Jhelum, materials are peculiarly imperfect. After, however, consulting several authorities, and comparing the extent of country drained by this river with the areas drained by others of known discharges, I am disposed to think that about 4,000 cubic feet per second would be a fair approximate estimate of the quantity of water in the Jhelum which might be made available for agricultural objects.

13. From the preceding details, it therefore appears that (neglecting minor streams) the three rivers above adverted to would furnish for irrigation a total supply of water equal to (Ravee 3,000 + Chenab 5,000 + Jhelum 4,000) 12,000 cubic feet per second; the whole, or very nearly the whole, of which is now running waste to the sea, without material benefit to the state or to the people.

14. In all that portion of the Trinab which has come under my personal observation, I have been much interested by noticing the very excellent and careful system of agriculture pursued by the people there. It was natural to suppose that the political troubles of the last ten years would have led to careless and indifferent husbandry, and to the abandonment of much cultivated soil. But, on the contrary, the style of cultivation was careful generally, and for valuable crops almost garden-like; the extent of land thrown out of use was much smaller than might have been expected, and found, indeed, only on the lines of military operations. The Khurreef crops (sugar-cane,

cotton, &c.) were uncut; and, accustomed as I am to the luxuriant crops in our own canal districts, I must say that the products of this portion of the Punjab did not appear to me inferior to these. Wells for irrigation are very numerous, and extensively employed. It may therefore be concluded, that a population thus industrious under unsettled and adverse circumstances, would speedily avail themselves of increased facilities to extend their cultivation when these were furnished to them; and especially when the enjoyment of the results was secured to them by a strong government, fixed and moderate in its own demands upon the soil.

15. Existing canals of irrigation in the Punjab, although on a much smaller scale than those now adverted to, have still tended to familiarize the people with such works, and to prepare them for their reception. It appears, therefore, to be a strong argument in favour of such a general system as is herein advocated, that the idea of it is by no means novel to the agricultural community, but in accordance with their own constant practice when the means are available, and having accordingly no prejudices to meet and overcome.

16. In proceeding now to exhibit approximate estimates of the probable costs and returns of the suggested works, it may be needful to premise, that the data employed are derived from actual experience on the canals in our own provinces, and modified, where modification seemed necessary, to adapt them to the present case. It is to be understood, that here, as in points previously examined, rigid accuracy is not affected, because it cannot at present be attained. But the limits of error are not great, and I believe the

results may be received with considerable confidence, as being nearly, if not quite, the truth.

17. It will be convenient, in examining this part of the subject, to consider separately the natural divisions into which the Trinab is formed, by the great rivers which intersect and bound it. These divisions are three in number, usually styled the Baree, Rechna, and Jetch Doabs.

18. The superficial area of the Baree Doab is estimated roughly, from such materials as are available, at about 11,000 square miles; of which 7,334 square miles, or 6,211,898 acres, may be considered as the proportion of the total area, either cultivated or culturable. For the irrigation of these 6¼ millions of acres, a supply of water equal to 3,000 cubic feet per second is available from the river Ravee. Now, from experience on canals in the provinces, it is known that each cubic foot of discharge is sufficient to water, during the year, 218 acres: hence it follows that, with the above supply from the Ravee, an area of 654,000 acres would be watered annually. Irrigating villages are found, however, to water only about one-third of their lands; the remaining two-thirds being either occupied by inferior crops, not requiring other irrigation than that of the usual rains, or allowed to lie fallow for the succeeding season. The supply of 3,000 cubic feet is therefore sufficient for the artificial irrigation of an area equal to three times that actually watered, or for 1,962,000 acres.

19. Further, in all tracts provided with artificial river irrigation, there are, invariably, certain localities which, from peculiarity of profile, are excluded from the benefits of the system. The diminution of cost and

labour, however, with which this kind of irrigation can be carried on, admits of an extension of wells in the unfavourable localities alluded to, and insures their being brought under cultivation. The two systems of canal and well irrigation are therefore found to co-exist, even in districts where the former has been most fully developed; and, from the settlement records of such districts, the general average proportion of areas irrigated by the two methods is as 10 to 1. Applying this to the present case, it appears that an additional section of the Baree Doab, amounting to 196,200 acres, would be efficiently irrigated from wells.

20. The total irrigated area of this Doab would therefore amount to 2,158,000 acres; being very nearly one-third of the cultivated and culturable, and one-fourth of the entire area of the tract. These are the proportions which are found to prevail in the second class canal districts of our own provinces; and in these the land affords to Government an annual revenue of about 1200 rs. per square mile of total area. As I am unfortunately ignorant of the amount of revenue at present derived from the Baree Doab, I am debarred from making the desirable comparison between what it actually is, and what it might become under the full development of the natural resources at command. If, however, the standard should become the same as that of the North-West Provinces, similarly provided with irrigation and with like capabilities of soil, the total land revenue would amount to 132,00,000 rs. or 1,320,000*l.* per annum; being an average of nearly 2 rs. 2 an. per acre on the cultivated and culturable, and 1 rupee 9 an. on the total areas: both rates which

I believe revenue officers would consider moderate, for lands so provided with means of irrigation as those of the Baree Doab would be.

21. In forming an estimate of the expense which must be incurred to supply irrigation to the extent before specified, reference must be had to works of like nature constructed in our own provinces. The cost per mile of the Western Jumna Canal, the discharge of which is nearly 2,200 cubic feet per second, has been about 2,500 rs. The Ganges Canal, intended to discharge 6,750 cubic feet per second, is estimated to cost (as a canal of irrigation only) nearly 6,000 rs. per mile. An estimate for the suggested canal from the Ravee, made at 4,000 rs. per mile, would therefore, I consider, be most liberal; and would admit of the various works, for obtaining the supply, controlling the drainage, regulating the slopes, and maintaining the cross communication of the country, being constructed in the most efficient and durable manner.

22. It is considered that a supply of water equal to 8 cubic feet per second is sufficient for each mile in length of a canal of irrigation in full activity. Consequently, the discharge of the Ravee (3,000 cubic feet) would be sufficient for an irrigating line 375 miles in length, or about 25 miles in excess of the total length of the Doab. The supply of water corresponding to this excess would readily be absorbed, and we may consider the length of the line as 350 miles; the cost of which, at 4,000 rs. per mile, would be 14,00,000 rs., or 140,000*l.*

23. To estimate the amount of annual expenses in repairs and establishments, existing canals furnish sufficient data. From my knowledge of these, I am

of opinion that an allowance of 400 rs. per mile would be found abundant to cover all current expenses of every kind, both as connected with the conservancy of the works and the collection of the revenue. The total annual expenditure would accordingly amount to 1,40,000 rs., or 14,000*l.*

24. It is assumed that it would be necessary for Government to borrow the funds wherewith to execute the projected works, and to cover all costs and charges thereby incurred. It appears to me that an annual charge of 10 per cent. on the capital sunk in their construction would be sufficient. This charge, amounting to 1,40,000 rs., just doubles the annual expenditure; making the total 2,80,000 rs., or 28,000*l.*

25. It is now necessary to take into consideration the probable returns from the works, and to exhibit their adequacy to cover all expenses. Returns from works of irrigation, as they affect the interests of the state, are of two classes:—

1st. Indirect; being the increase of land revenue always derived from lands supplied with superior facilities of irrigation, as compared with that from lands not so supplied. I am not in possession of information sufficient to enable me to estimate this accurately in the present case. Such information, however, probably exists in the office of the Lahore Residency, and would be obtained from a comparison of the average revenue per acre, or per square mile, of the tract of country under the influence of the existing canal from the Ravee, with that of other portions of the Doab in unirrigated localities. To give, however, a distinct idea

of the probable amount of the indirect returns in the case under notice, I may mention that, in the North-West Provinces, a tract of country, 2,300 square miles in area, irrigated as a like area of the Baree Doab would be, would yield to Government, at a low estimate, a land revenue of 6,00,000 rs. in excess of that derived from a similar tract not provided with means of artificial river irrigation. This estimate is based upon the results of the statistical researches in the canal districts of the North-West Provinces, undertaken by order of the Agra Government; and is, I believe, a very moderate one.

2nd. Direct revenue; being the proceeds of the sale of water to the cultivators, and miscellaneous items from the application of the water-power to mills, transit duties on produce carried by the canal, &c. The charge made by Government on existing canals for water, averages exactly one rupee per acre per annum, and the amount of miscellaneous income may be estimated moderately at about one-twentieth of the total water-rent. From these data, an approximate estimate of the direct returns of a canal of irrigation from the Ravee may be formed as follows:—

	Rupees.	Rupees.
Water-rent on 654,000 acres, at 1 rupee per acre		6,54,000
Miscellaneous revenue $\frac{1}{20}$th of above		32,700
TOTAL ANNUAL DIRECT REVENUE		6,86,700
DEDUCT EXPENSES:—		
Current expenses, per annum	1,40,000	
Interest at 10 per cent. on 14,00,000 rupees of capital invested	1,40,000	
Total annual expenditure		2,80,000
SURPLUS ANNUAL REVENUE		4,06,700

26. It is, perhaps, scarcely necessary to add that the above estimate, showing a return of about 28 per cent. on the capital invested, assumes the fullest development of the proposed system of irrigation, and therefore gives results more favourable than would follow at first in actual experience. But the influence of the system would become perceptible immediately upon the admission of water into the channels, and year by year it would be found to increase, until the maximum development was attained. This expectation finds, perhaps, its surest guarantee in the history of our own canals, and the results derived from them. The Western Jumna Canal, after twenty-five years of existence, has paid all its own expenses for repairs and establishments, 5 per cent. annually on the capital invested in it, and a surplus revenue which, during the current year, will amount to 20,00,000 rs., or 200,000*l.* It now returns to Government, by direct and indirect revenue, about 38 per cent. on the amount of the capital required for its construction. The Eastern Jumna Canal, after about eighteen years existence, and with very heavy charges upon it, has paid interest and expenses as above, and during the current year will commence the accumulation of surplus revenue. This work returns at present 24 per cent. on its capital. It may therefore be safely concluded that, within ten or twelve years from its completion, the Ravee Canal would not only have greatly benefited the country, but would have become an important source of revenue to the Government.

27. Proceeding now to the Rechna Doab, or the

country between the rivers Ravee and Chenab, we find its total area to be, roughly, about 8,000 square miles; of which 5,334, or 4,517,898 acres, may be considered cultivated or culturable land. The supply of water available for the irrigation of this tract from the Chenab has been estimated at 5,000 cubic feet per second—sufficient to water annually 1,090,000 acres, and to supply all the irrigation required, according to the highest standard, to 3,270,000 acres. Hence the Rechna Doab is capable of irrigation to the extent of three-fourths of its cultivated and culturable, and half its total areas; proportions equal to those of the very best irrigating districts in the North-Western Provinces. From such districts Government derives a land revenue amounting to a little more than 1,600 rs. per square mile. By this standard the revenue of the Rechna Doab would in time amount to 1,28,00,000 rs., or 1,280,000*l.* per annum. What it actually is, I have no means at present of ascertaining.

28. The supply of water available from the Chenab (5,000 cubic feet per second) would be sufficient for 625 miles in length of canal channels; the precise distribution of which must be dependent on circumstances, only to be determined by careful surveys and inquiries. Supposing, however, the cost of these main channels to be, as before, 4,000 rupees per mile, the total cost of irrigating the Rechna Doab would amount to 24,00,000 rs., or 240,000*l.*

29. According to the scale previously employed, the annual current expenses for works and establishments would amount to 2,50,000 rs., and the interest and charges connected with the borrowed capital

to 2,40,000 rs., making the total annual charge 4,90,000 rs.

30. To estimate the indirect returns for the present case, reference must be had, as formerly, to districts similarly provided with irrigation in our own provinces. According to that scale, the Rechna Doab would yield an annual land revenue amounting to at least 15½ lakhs of rupees, in excess of the maximum which would be derived from it in its present unimproved condition.

31. The direct returns may be exhibited as follows:—

	Rupees.	Rupees.
Water-rent on 1,090,000 acres, at 1 rupee per acre		10,90,000
Miscellaneous revenue, $\frac{1}{20}$th of above		54,500
TOTAL ANNUAL DIRECT REVENUE		11,44,500
DEDUCT EXPENSES:—		
Current annual expenses	2,50,000	
Interest at 10 per cent. on 24,00,000 rupees of invested capital	2,40,000	
Total annual expenditure		4,90,000
SURPLUS ANNUAL REVENUE		6,54,500

This surplus, which represents the maximum result attainable, would give to Government 27 per cent. on the invested capital.

32. It only now remains to consider the case of the Jetch Doab, or the country between the rivers Chenab and Jhelum. The area of this may be roughly estimated at 5,000 square miles, whereof 3,334, or 2,823,898 acres are cultivated or culturable land. The supply of water to be procured from the Jhelum, and made available for the irrigation of this tract, has been estimated at 4,000 cubic feet per second, sufficient to water 872,000 acres, and to

furnish the necessary irrigation for an area of 2,616,000 acres. Hence (including extra well irrigation) the entire cultivated and culturable land of this Doab might be thoroughly supplied with water for agricultural purposes,—a state of affairs which has no parallel in our own provinces. Means of comparison for the amount of land revenue in such a case are therefore wanting; but, supposing the standard to be only the same as in the Rechna Doab, it appears that in due course Government might derive from the Jetch Doab a revenue amounting to 80,00,000 rs., or 800,000*l.* per annum.

33. The supply from the Jhelum (4,000 cubic feet per second) is sufficient to maintain 500 miles of irrigating channel; and, supposing the expense to be as before, 4,000 rs. per mile, the total amount required for the Jetch Doab would be 20,00,000 rs., or 200,000*l.*

34. The excess of land revenue due to the extent of irrigated surface would amount to upwards of 12 lakhs of rupees per annum, according to the scale employed in the case of the Rechna Doab.

36. The direct returns may be estimated as follows:—

	Rupees.	Rupees.
Water-rent on 872,000 acres, at 1 rupee per acre .		8,72,000
Miscellaneous revenue, $\frac{1}{20}$th of above . . .		43,600
TOTAL ANNUAL DIRECT REVENUE .		9,15,600
DEDUCT EXPENSES:—		
Current annual expenses	2,00,000	
Interest at 10 per cent. on 20,00,000 rupees of invested capital	2,00,000	
Total annual expenditure		4,00,000
SURPLUS ANNUAL REVENUE . .		5,15,600

This surplus would give nearly 25 per cent. on the total amount of capital required.

37. Having thus completed the details illustrative of the proposed system of irrigation in the Trinab, it may be useful to exhibit these here in a condensed numerical form, and with this view I have prepared the subjoined table:—

NUMERICAL SUMMARY OF DETAILS CONNECTED WITH THE IRRIGATION OF THE TRINAB, OR THAT PORTION OF THE PUNJAB BETWEEN THE BEAS, SUTLEDGE, AND JHELUM.

Districts.	Areas.			Expenditure for Irrigation.		Revenues.		Returns on Capital.
	Total Square Miles.	Cultivated and Culturable.		Original Works.	Annual Current Expenditure.	Land Revenue as in like Irrigated Districts in N. W. P.	Net Revenue deducting current expenses.	Per Centage on amount of capital from Net Canal Reven.
		Square Miles.	Acres.					
				Rs.	Rs.	Rs.	Rs.	
Baree Doab..	11,000	7,884	6,211,898	14,00,000	2,80,000	132,00,000	4,06,700	28
Rechna Doab	8,000	5,334	4,517,898	24,00,000	4,80,000	128,00,000	6,54,500	27
Jetch Doab ..	5,000	3,334	2,923,898	20,00,000	4,00,000	80,00,000	5,15,600	25
Totals....	24,000	16,002	13,653,694	58,00,000	11,70,000	340,00,000	15,76,800	26·6

38. From this summary it accordingly appears that, by a total expenditure of 58,00,000 rs., or 580,000*l.*, in works for applying to agricultural uses the now waste waters of the Ravee, Chenab, and Jhelum, an annual land revenue, amounting to 340,00,000 rs., or 3,400,000*l.*, might be obtained from the districts under the influence of these rivers. I have already had occasion to observe, that I am not aware of the amount of revenue at present drawn from these districts; but I believe, in the best times of Runjeet Singh's reign, it was far below the amount specified above.

39. If the land revenue of the Sind-Sagur Doab, or the country between the Jhelum and the Indus, with the general miscellaneous revenues of the country from salt, customs, &c., be taken into consideration, it appears probable that the Punjab westward of the Indus, might, in reasonable time, be made to yield to Government a revenue of not less than four millions sterling,—inclusive, however, of whatever portion thereof may have been alienated from the state in jagheers; the amount of which I have no means of estimating, even approximately.* Under the system I have proposed, the country would not only defray its due military and civil charges, but would ultimately yield a considerable surplus revenue for the general purposes of Government.

40. Throughout this memorandum, I have dwelt especially on the benefits the State would derive from the measures proposed; but the advantages they would secure to the people would not be inferior. The agricultural products of the land would be placed beyond the vicissitudes of season; a certain return would be guaranteed to labour and capital; abun-

* The following is an approximate statement of the present revenue of the Punjab:—

	Rupees.		£	
Baree Doab . . .	23,00,000	or	230,000	per annum.
Rechna Doab . . .	40,00,000	or	400,000	„
Jetch Doab . . .	9,00,000	or	90,000	„
Sind-Sagur Doab . .	14,00,000	or	140,000	„
Dera Jurail Khan . .	5,00,000	or	50,000	„
Peshawur	7,50,000	or	75,000	„
Hazareh	2,00,000	or	20,000	„
Miscellaneous . . .	14,00,000	or	140,000	„
Jagheers and Religious Endowments,	56,00,000	or	560,000	„
Total . .	1,70,50,000	or	1,705,000	„

dant and permanent occupation would be provided for the agricultural classes, and in their prosperity the other classes of the community would necessarily participate. The actual produce of the soil is materially increased by plentiful irrigation; the average quantity per acre in irrigated lands being, according to revenue survey statistics, about 600 lbs. in excess of that land not irrigated, for the Rubbee or cold weather crops of wheat, barley, &c.; while the valuable rain or Khurreef crops, as sugar, cotton, &c., cannot be reared at all without irrigation. It may perhaps be instructive to exhibit, in numerical form, the increase and probable value of the produce from the Trinab under the system herein suggested. The total area which could be watered by the united supplies of the Ravee, Chenab, and Jhelum, amounts to 3,706,000 acres; and, estimating the surplus produce per acre at only 400 lbs., the total increase would amount to 1,482,400,000 lbs., or 18,530,000 maunds; which, at 1 rupee per maund, would give an annual increase of agricultural wealth equal to 1,85,30,000 rs., or 1,853,000*l*. This calculation has reference only to the Rubbee crops, and it would be easy to multiply such illustrations were it necessary; but as the influence of extensive and economical irrigation in increasing the material prosperity of the people, as exhibited in the canal districts of the North-West Provinces, is well known to Government, and to all parties connected with these districts, further details do not appear to be required.

41. To those who have observed carefully the influence of the canal system on the people, the moral effects of their improved material condition are very

perceptible. Castes and tribes whose habits of life have been long pastoral or predatory, are seen gradually to abandon these and to become settled and industrious agriculturists. My personal experience would enable me to point out many examples of such changes, even within the course of the last ten years; and, looking to the present condition of the Seikhs, a people which would seem to have but two national pursuits, arms and agriculture, I am disposed to think that no resource would tend more directly to their permanent pacification, than, while depriving them of the power to earn subsistence by the sword, to furnish them abundantly with the means of gaining it by the plough.

(Signed) R. BAIRD SMITH, *Engineers*,

Superintendent Eastern Jumna Canal, and Assistant Field Engineer with the Army of the Punjab.

Camp, Chilianwala,
29th Jan. 1849.

London: Printed by STEWART and MURRAY, Old Bailey.